

**Data Collection and Development of Essential Components to
Support the Development of a Watershed Protection Plan for
Lake Lavon**

**FINAL REPORT
TSSWCB PROJECT #16-62**



**TEXAS A&M AGRILIFE EXTENSION SERVICE
IN PARTNERSHIP WITH NORTH TEXAS MUNICIPALWATER DISTRICT**

**Funding provided by Texas State Soil and Water Conservation Board through a
State Nonpoint Source Grant**

Executive Summary:

Lavon Lake Watershed encompasses a 769 square mile (492,095 acre) area in north Texas including parts of Collin, Fannin, Grayson, and Hunt Counties. Lavon Lake is the primary source of water supply administered by the North Texas Municipal Water District (NTMWD) for the surrounding area, and serves as a flood control and water conservation reservoir. Four major tributaries contribute water to the lake. These are the East Fork of the Trinity River, Pilot Grove Creek, Sister Grove Creek, and Wilson Creek. The East Fork of the Trinity River and Wilson Creek were identified as impaired on the Texas Commission on Environmental Quality (TCEQ) 2010, 2012, and 2014 Integrated Report for Surface Water Quality due to elevated levels of E. coli bacteria. In order to address these impairments, and to prevent other water quality issues from developing in the watershed, Lavon Lake was selected for the development of a Watershed Protection Plan (WPP). This decision was made through collaborative dialogue between the NTMWD, Texas State Soil and Water Conservation Board (TSSWCB), and Texas A&M AgriLife Extension Service (AgriLife) based on criteria that included the aforementioned tributaries having been identified on the Integrated Report, potential for success, ongoing activities, and level of stakeholder interest in protecting Lavon Lake from pollution.

In order to develop a Watershed Protection Plan (WPP) for Lavon Lake, the project ‘Data Collection and Development of Essential Components to Support the Development of a Watershed Protection Plan for Lake Lavon’ was funded by TSSWCB and initiated in collaboration with NTMWD and AgriLife Extension. The project was initiated in February of 2016 and concluded in April, 2018. City and county staff in the watershed were brought to the table early (1st quarter) to discuss the goals of the project and convey the importance and scope of watershed protection planning. Public meetings were held in both Wylie and McKinney in September 2016, and soon thereafter, the Lavon Lake Watershed Partnership was formed to guide development of the Lavon Lake Watershed Protection Plan. Between November 2016 and June 2017, the Partnership met eight times to develop the Lavon Lake Watershed Protection Plan. The Partnership recognized that success in improving and protecting water resources depends on the people who live, work, and recreate in the watershed. The Lavon Lake Watershed Protection Plan was conceived to serve as a guidance document for protecting water quality at the local level.

AgriLife was responsible for project administration, including the submission of quarterly reports and invoices for project related cost reimbursements. AgriLife and NTMWD were responsible for watershed partnership facilitation. Collection, analysis, and reporting of the necessary data to support the WPP for Lavon Lake was performed by NTMWD, who was also responsible for developing data quality objectives (DQOs) and quality assurance/control (QA/QC) activities to ensure data of known and acceptable quality were generated through this project. Further data analysis and modeling components were provided by the Texas A&M Spatial Sciences Laboratory (SSL) and the Texas A&M Department of Biological and Agricultural Engineering (BAEN). Landuse/landcover data were provided by SSL for use in SELECT analysis. BAEN was responsible

for preparing flow and load duration curves (LDCs), and for developing, a new and improved pollutant source analysis by incorporating fate and transport of bacterial to identify priority areas based on LDCs.

The project was successful in meeting all of its objectives for collecting data and developing the essential components for a WPP for Lavon Lake. A Partnership was formed and provided valuable input as to recommended management measures in urban and agricultural settings to reduce bacteria and prevent pollution from nutrients, sediment, and hazardous materials. Other key management measures identified by the Partnership were focused on septic system management, illegal dumping cleanup and enforcement, managing feral hog populations, and proper disposal of hazardous waste. In addition, the Partnership stressed the importance of projects to restore degraded wetlands, streams, and riparian areas, and it was noted that nonprofit land trust organizations might provide a viable mechanism for protecting environmentally sensitive areas in the watershed. Flow and LDCs were developed for inclusion into the WPP, as were improvements to the Spatially Explicit Load Enrichment Calculation Tool (SELECT) analysis software.

The SELECT tool has been used as part of WPP development in Texas to assess potential hotspots and sources of bacterial contamination in watersheds. Originally automated within Geographic Information Systems (GIS) using Visual Basics for Applications (VBA), SELECT users could parameterize specific water bodies using a Graphical User Interface (GUI). However, VBA is no longer supported by current and future versions of the ArcGIS software. Specific objectives of this component of the project included 1) implementing a modeling scheme that applied the SELECT methodology for use in the current version of ArcGIS using the Python coding language; 2) developing a GUI for domestic fecal sources using publically accessible data, and 3) applying an *E. coli* transport model using the curve number method. Additionally, Map Algebra and Spatial Analyst functions have been incorporated into the improved tool with the new title “pySELECT”.

Project Overview and Accomplishments:

The project activities and specific tasks were described in the project work plan. The duration of the project as specified in the work plan was from February 1, 2016 to April 31, 2018.

Task1: Project Administration (AgriLife) - coordination and monitoring of all work performed under the project, including “technical and financial supervision and preparation of status reports”. Deliverables for this task included:

- Quarterly Reports (QPRs)
- Reimbursement Forms and necessary documentation in hard copy format.
- Final Report in electronic and hard copy formats.

Seven QPRs were submitted to the TSSWCB by AgriLife in cooperation with NTMWD. Reimbursement forms were submitted on a quarterly basis to AgriLife by NTMWD, BAEN, and SSL to be summarized and approved for final submission to TSSWCB. Any objections, refusals, or clarifications regarding charges submitted on behalf of any party was handled and communicated by AgriLife. AgriLife maintained coordination and communication between all

project partners (TSSWCB, NTMWD, BAEN & SSL) for the duration of the project. The Final Report was written and submitted by AgriLife with facilitation and input from NTMWD.

Task 2: Quality Assurance (NTMWD, SSL, and BAEN) - develop data quality objectives (DQOs) and quality assurance/control (QA/QC) activities to ensure data of known and acceptable quality are generated through this project. Deliverables included:

- QAPP approved by TSSWCB in both electronic and hard copy formats.
- Approved revisions and amendments to QAPP, as needed.
- Data of known and acceptable quality as reported through Task 3.

A Quality Assurance Program Plan (QAPP) was written for the water quality (WQ) monitoring activities performed by NTMWD, and for the SELECT work to be used in the development of the WPP performed by BAEN (Task 4). The WQ QAPP was completed in March of 2016 and accepted prior to the end of the first quarter of the project. A draft of the QAPP for the modeling and analytical components was submitted to TSSWCB for review within the first quarter and approved within the second quarter of the project. The approved QAPPs were distributed to all project partners, as well as staff and field personnel involved in data collection and analysis. All data and analysis reported through Task 4 were compliant with the guidelines and procedures described in these QAPPs.

Task 3: Develop new and improved pollutant source analysis (BAEN) - Improve the capabilities and functions of SELECT software and analysis

- Improved and updated SELECT software in ArcGIS using python coding.

BAEN has improved the software and provided the results to NTMWD for inclusion into technical reports submitted to TSSWCB. The results of this work are published in Borel et al. (2017)*. In brief, BAEN successfully reprogrammed SELECT in the Python language and updated the graphical user interface and four modules.

- Potential *E. coli* loads for dogs and
- Failing on-site wastewater treatment systems (OWTS)
- Rainfall runoff using USDA-NRCS curve number look-up table **
- *E. coli* transport model

The pySELECT results from potential *E. coli* load modules for dogs and for OWTS were simulated in the curve number and *E. coli* transport modules. These improvements were verified by manual calculation for the Lavon Lake watershed.

*Borel, K., Swaminathan, V., Vance, C., Roberts, G., Srinivasan, R. and Karthikeyan, R., 2017. Modeling the Dispersion of E. coli in Waterbodies Due to Urban Sources: A Spatial Approach. *Water*, 9(9), p.665.

** USDA-NRCS Urban Hydrology for Small Watersheds. 1986. Available online:
ftp://ftp.odot.state.or.us/techserv/Geo-Environmental/Hydraulics/Hydraulics%20Manual/Chapter_07/Chapter_07_appendix_G/Urban_Hydrology_for_Small_Watersheds.pdf

Task 4: Conduct water quality monitoring and data analysis (NTMWD, SSL, & BAEN) - Conduct water quality monitoring and data analysis to support development of the Lake Lavon Watershed Protection Plan, including evaluation and prioritization of best management practices to improve water quality. Deliverables include:

- Water quality data
- Technical reports detailing water quality, land use/land cover analysis, and modeling results

NTMWD began collecting in-stream water quality data in April 2016. NTMWD continued to monitor and report data as outlined in the WQ QAPP through the project duration. The North Texas Municipal Water District, with support from AgriLife and the TSSWCB initiated an extensive water quality monitoring program in the Lavon Lake watershed as part of this. The goal of this effort was to better characterize water quality across the watershed and to assist the Steering Committee and Partnership in developing an implementation strategy.

Starting in April 2016, NTMWD began collecting monthly water quality samples at twenty locations in the Lavon Lake watershed (Figure 1 and Table 1). These data provided a higher degree of resolution and understanding about the extent of pollutant loads in the watershed and were used to identify any unknown, major sources of pollution.

Data collection at these sites continued for 18-months and concluded in September 2017. Although the vast majority of sampling attempts were successful, some locations were located on ephemeral stream reaches that were dry for extended periods. Therefore, the total number of samples collected for each location during this 18-month period ranged from 12-18 samples. All data was collected in compliance with the approved QAPP developed as part of Task 2 and were analyzed for a full suite of physical and chemical water quality parameters. These data were submitted to TCEQ for inclusion in the Surface Water Quality Monitoring Information System (SWQMIS database).

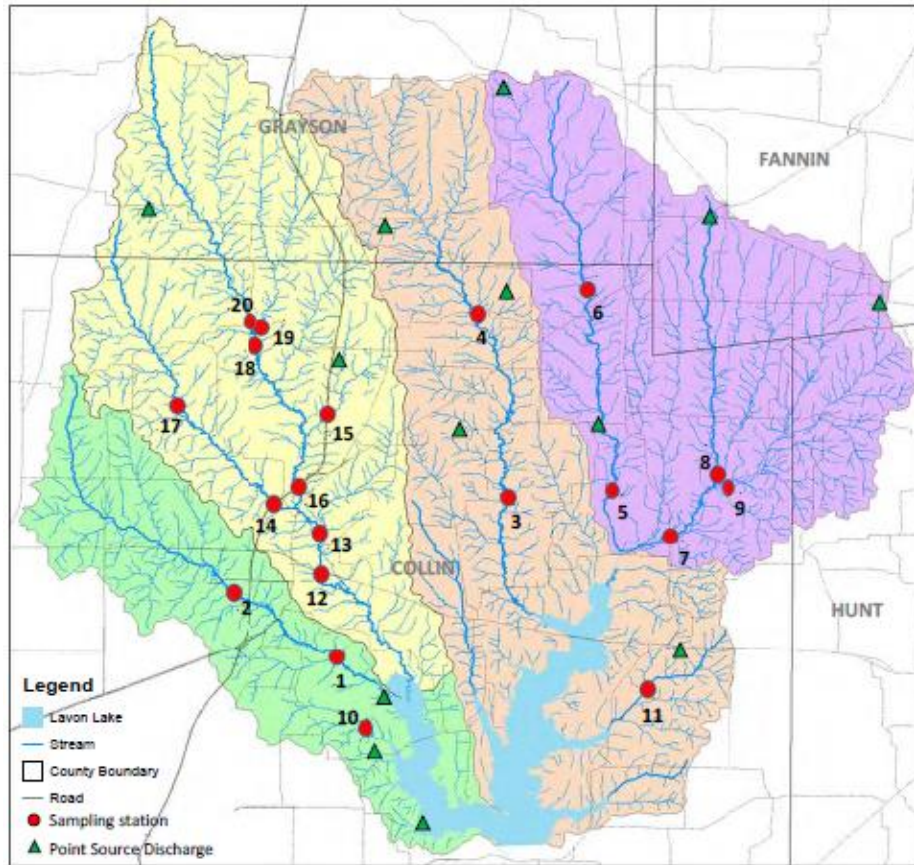


Figure 1. Lavon Lake Watershed and Sampling Locations

Data Analysis

Analysis of the data collected to-date was conducted in June 2017 to identify statistical differences between monitoring locations for *E. coli*, Total Nitrogen, and Total Phosphorus. In Table 2, sites with mean pollutant values that are statistically significant are designated with a plus symbol. For example, the mean TP values for samples collected at sites 21773 and 21777 are statistically different from one another and from all other mean values.

Although analysis showed a statistical difference in mean *E. coli* at site 21770, this was based on fewer data points. This monitoring site is located on an ephemeral stream, which typically only flows for a short time following a period of rainfall. Consequently, the stream was dry for all but ten of the monthly sampling attempts. The relatively high *E. coli* concentrations in these samples is likely due to the flushing of bacteria from upland areas that often occurs after a rainfall event. In fact, weather station data show that significant rainfall had occurred during the two week period prior to the collection of these samples.

Site	Site Name	TCEQ Site ID	Description
1	Lower Wilson Creek	21764	WILSON CREEK AT CR317 NEAR MCKINNEY
2	Upper Wilson Creek	21765	WILSON CREEK AT FOOT BRIDGE NEAR PARK VIEW AVENUE IN MCKINNEY
3	Sister Grove Creek	21766	SISTER GROVE CREEK AT CR 470 APPROXIMATELY 6 MILES SW OF MELISSA
4	Headwaters Sister Grove Creek	21767	SISTER GROVE CREEK AT CR2862 APPROXIMATELY 4 MILES NE OF ANNA
5	Pilot Grove Creek	15692	PILOT GROVE CREEK IMMEDIATELY DOWNSTREAM OF COLLIN CR 574 AND 3.2 MI SOUTH OF FM 5545 NEAR BLUE RIDGE
6	Headwaters Pilot Grove Creek	21768	PILOT GROVE CREEK AT CR 584 APPROXIMATELY 2.5 MILES NE OF
7	Indian Creek	21769	INDIAN CREEK AT SR 78 APPROXIMATELY 4.5 MILES NORTH OF FARMERSVILLE
8	Bear Creek-Indian Creek	21770	BEAR CREEK AT CR 622 APPROXIMATELY 7 MILES NORTH OF FARMERSVILLE
9	Arnold Creek	21771	ARNOLD CREEK AT CR 664 APPROXIMATELY 6.5 MILES N. OF FARMERSVILLE
10	White Rock Creek	21772	WHITE ROCK CREEK AT SNIDER LANE IN LUCAS
11	Elm Creek	21773	ELM CREEK AT CR 605 APPROXIMATELY 3 MILES SW OF FARMERSVILLE
12	East Fork Trinity River 1	21774	EAST FORK TRINITY RIVER AT US 380/EAST UNIVERSITY DRIVE NEAR MCKINNEY
13	East Fork Trinity River 2	21775	EAST FORK TRINITY RIVER AT CR 331 NEAR MCKINNEY
14	Lower Honey Creek	21776	HONEY CREEK AT US 75 NEAR MCKINNEY
15	Throckmorton Creek	21777	THROCKMORTON CREEK AT US 75 APPROXIMATELY 1.5 MILES NE OF MELISSA
16	East Fork Trinity River 3	21778	EAST FORK TRINITY RIVER AT US 75 NE OF MCKINNEY
17	Upper Honey Creek	20932	HONEY CREEK 40 M UPSTREAM OF COLLIN CR 170 4.3 KM SW OF WESTON AND 2.3 KM NORTHWEST OF INTERSECTION OF FM 543 AND COLLIN CR 170
18	East Fork Trinity River 4	21779	EAST FORK TRINITY RIVER AT CR 210 APPROXIMATELY 1.8 MILES EAST OF WESTON
19	Whites Creek	21780	WHITES CREEK AT CR 455 APPROXIMATELY 2.4 MILES NE OF WESTON
20	East Fork Trinity River 5	21781	EAST FORK TRINITY RIVER AT CR 455 APPROXIMATELY 1.8 MILES NE OF WESTON

Table 1. Monitoring sites at Lake Lavon Watershed.

Sites 21773 and 21777 are downstream of the Farmersville and Slayter Creek WWTPs, respectively. This may explain the elevated nutrient levels at these locations. Review of the NPDES permit data show there are limits in place for ammonia-nitrogen, but not for phosphorus at these facilities. However, further investigation will be needed to confirm upstream sources of nutrients at these monitoring locations.

Site Name	TCEQ Site ID	<i>E. coli</i> (cfu/100mL)			Total Nitrogen (mg/L)			Total Phosphorus (mg/L)		
		mean	p	n	mean	p	n	mean	p	n
Lower Wilson Creek	21764	354.5		15	8.25		14	0.08		14
Upper Wilson Creek	21765	537.8		16	1.21		15	0.06		15
Sister Grove Creek	21766	786.6		16	1.20		15	0.20		15
Upper Sister Grove Creek	21767	526.0		16	1.04		15	0.24		15
Pilot Grove Creek	15692	840.9		14	1.37		13	0.22		13
Upper Pilot Grove Creek	21768	1012.1	+	11	0.84		11	0.16		11
Indian Creek	21769	568.7		16	1.42		15	0.22		15
Bear Creek-Indian Creek	21770	1202.0	+	10	1.63		9	0.30		9
Arnold Creek	21771	779.9		15	1.33		15	0.26		15
White Rock Creek	21772	551.8		16	0.91		15	0.05		15
Elm Creek	21773	1009.8	+	16	43.3	+	15	1.94	+	15
East Fork Trinity River 1	21774	623.7		15	1.74		14	0.20		14
East Fork Trinity River 2	21775	371.4		15	1.69		15	0.21		15
Lower Honey Creek	21776	554.0		15	0.92		15	0.09		15
Throckmorton Creek	21777	382.0		14	10.1		13	0.90	+	13
East Fork Trinity River 3	21778	387.8		15	2.05		14	0.24		14
Upper Honey Creek	20932	508.3		16	0.71		15	0.07		15
East Fork Trinity River 4	21779	344.3		16	1.54		15	0.10		15
Whites Creek	21780	612.5		12	1.68		11	0.11		12
East Fork Trinity River 5	21781	437.6		16	1.48		15	0.06		15

Table 2. Water quality monitoring results from Lake Lavon.

Task 5: Watershed Partnership Facilitation (NTMWD & AgriLife) - Work with local stakeholders and partner agencies to form a watershed partnership and steering committee to support the development of a watershed protection plan for Lake Lavon. Deliverables include:

- Meeting agendas
- Meeting attendance lists
- News releases and meeting announcements

To inform and educate citizens from across the watershed and engage them in the planning process, an information and education campaign was conducted at the outset of the project. Press releases were developed and delivered in the watershed in advance of the planning process using key media outlets including local newspapers and newsletters. Stakeholders were defined as those who make and implement decisions, those who are affected by the decisions made, and those who have the ability to assist with implementation of the decisions.

Following these efforts, two public meetings were announced and held on two dates in September 2016, with one in McKinney, TX and one in Wylie, TX. Seventy-eight stakeholders attended these public meetings where information was provided regarding conditions in the Lavon Lake watershed and the proposed development of a WPP. Participants were invited to

become members of the Lavon Lake Watershed Partnership and asked to help notify other potential stakeholders that should be part of the process.

Monthly public meetings facilitated by North Texas Municipal Water District and AgriLife were held in the watershed. Technical issues were presented in detail to the Partnership for discussion and evaluation, and recommendations were developed and forwarded to the Steering Committee for consideration and approval. All meetings were open to the public, with announcements sent out via e-mail and news release, and posted on the project website. A total of eight Partnership meetings were conducted during the plan development process.

- September 20, 2016 – Project Kickoff Meeting
- October 13, 2016 – Project Kickoff Meeting
- November 15, 2016 – Lavon Lake Watershed Partnership Meeting
- December 13, 2016 – Lavon Lake Watershed Partnership Meeting
- January 24, 2017 – Lavon Lake Watershed Partnership Meeting
- February 21, 2017 – Lavon Lake Watershed Partnership Meeting
- March 28, 2017 – Lavon Lake Watershed Partnership Meeting
- April 25, 2017 – Lavon Lake Watershed Partnership Meeting
- May 23, 2017 – Lavon Lake Watershed Partnership Meeting
- June 20, 2017 – Lavon Lake Watershed Partnership Meeting

A Steering Committee composed of stakeholders from the Lavon Lake Watershed was formed to serve as a decision making body for the Partnership. To obtain equitable geographic and topical representation, solicitations for Steering Committee members were conducted using three methods: 1) as part of the public meetings held in the watershed, 2) at meetings with various stakeholder interest groups and individuals, 3) and following consultation with Texas A&M AgriLife Extension Service County Agents, Soil and Water Conservation Districts in the watershed, and local and regional governments. Self-nomination or requests by various stakeholder groups or individuals were welcomed.

The Steering Committee was designed to reflect the diversity of interests within the Lavon Lake Watershed and to incorporate the viewpoints of those who will be affected by the WPP. Members include both private individuals and representatives of organizations and agencies. Size of the Steering Committee was limited to 15 members solely for reasons of practicality. Types of stakeholders represented on the Steering Committee were:

- Land owners
- Business and industry representatives
- Agriculture producers
- Educators
- County and city officials
- Citizen groups
- Environmental and conservation groups

- Soil and water conservation districts

Ground rules were developed in order for the members to understand their roles and responsibilities, as well as, to provide guidance throughout the development and implementation of the WPP. Clear ground rules added structure and improved the efficiency of the group.



Image 1. Stakeholder meeting for Lavon Lake Watershed Partnership.



Image 2a and 2b: NTMWD and AgriLife discuss urban riparian restoration project during Lavon Lake Watershed tour



Image 3a and 3b: Local farmer/stakeholder (top) and AgriLife (bottom) discuss agricultural nutrient management in a wheat field during the Lavon Lake Watershed Tour.

Conclusion

TSSWCB project 16-62 titled “Data Collection and Development of Essential Components to Support the Development of a Watershed Protection Plan for Lake Lavon” has been completed and should be characterized as successful in achieving its goals of providing critical supporting data and information necessary for the development of a stakeholder-driven watershed protection plan for Lake Lavon. In working towards those goals, the partners (TSSWCB, EPA, AgriLife, BAEN, and the stakeholder group) maintained a focus on satisfying the EPA’s nine elements for acceptance, while also improving the SELECT analysis tool for pollutant source identification. SELECT improvements included additional module incorporation and updated coding to remain compatible with ArcGIS. All tasks and associated deliverables have been completed.

With the completion of this project, a companion project (17-51) is ongoing. This project “Development of a Watershed Protection Plan for Lake Lavon” will complete the process of developing an approved WPP for Lake Lavon and moving towards the potential for an implementation phase in watershed protection.

List of Acronyms

BAEN	Texas A&M Department of Biological and Agricultural Engineering
DQO	Data Quality Objective
GIS	Geographic Information Systems
GUI	Graphical User Interface
LDC	Load Duration Curves
NTMWD	North Texas Municipal Water District
QA/QC	Quality Assurance / Quality Control
QAPP	Quality Assurance Program Plan
QPR	Quarterly Report
SELECT	Spatially Explicit Load Enrichment Calculation Tool
SSL	Texas A&M Spatial Sciences Laboratory
SWQMIS	Surface Water Quality Monitoring Information System
TCEQ	Texas Commission on Environmental Quality
TSSWCB	Texas State Soil and Water Conservation Board
USDA-NRCS	United States Department of Agriculture – Natural Resource Conservation Service
VBA	Visual Basics for Applications
WPP	Watershed Protection Plan